CLAIMS

What is claimed is:

1. A sound system, comprising:

a left speaker and a right speaker located in close proximity;

a left channel audio signal;

a right channel audio signal; and

a sound processor receiving as inputs said left channel audio signal and said right channel audio signal, said sound processor configured to cross-cancel a spectrally weighted stereo difference signal with said left channel audio signal and said right channel audio signal prior to applying said left channel audio signal and said right channel audio signal to said left speaker and said right speaker, respectively.

2. The sound system of claim 1, wherein said sound processor is configured to generate a difference signal representing a difference between said left channel audio signal and said right channel audio signal, and to apply a spectral weighting to said difference signal thereby generating said spectrally weighted signal.

3. The sound system of claim 2, wherein said sound processor comprises a subtractor for generating said difference signal.

4. The sound system of claim 2, wherein said sound processor comprises a spectral weighting filter for applying said spectral weighting to said difference signal, said spectral weighting filter being characterized by a first filter region of relatively level gain, a second filter region having a generally decreasing gain with increasing frequency, and a third filter region of relatively level gain.

5. The sound system of claim 4, wherein said spectral weighting filter is further characterized by a roll-off from said first filter region to said second filter region at approximately 200 Hertz.

6. The sound system of claim 5, wherein said spectral weighting filter is further characterized by a boundary between said second filter region and said third filter region at approximately 2 KHz.

7. The sound system of claim 2, wherein said sound processor comprises a linear filter for applying the spectral weighting to said difference signal.

8. The sound system of claim 1, wherein said sound processor further comprises a phase equalizer for equalizing the phase of said spectrally weighted difference signal prior to cross-cancellation, and a plurality of phase compensators, having a phase characteristic complementary to said phase equalizer and said spectral weighting filter over a frequency band of desired cross-cancellation, placed in series along each of said left channel audio signal and right channel audio signal, respectively, prior to cross-cancellation.

9. The sound system of claim 8, wherein said phase equalizer comprises a plurality of all pass filters collectively having a first phase transfer function, and wherein each of said phase compensators comprises a plurality of all pass filters collectively having a second phase transfer function complementary to a combined phase characteristic of said phase equalizer and said spectral weighting filter over a frequency band of desired cross-cancellation.

10. The sound system of claim 8, wherein said phase equalizer comprises a second order filter.

11. The sound system of claim 1, wherein said left channel audio signal comprises a surround left channel audio signal coupled to a surround left speaker, wherein said right channel audio signal comprises a surround right channel audio signal which is coupled to a surround right speaker, and wherein said left speaker and said right speaker comprise a surround back left speaker and a surround back right speaker, respectively, for utilization in a surround sound stereo system.

12. The sound system of claim 1, wherein said sound processor is implemented in whole or in part in the digital domain.

13. A system for adaptive sound reproduction in a manner so as to enlarge the perceived area and stability of a stereo sound image, comprising:

a left speaker and a right speaker located in close proximity;

a left channel audio signal;

a right channel audio signal;

a subtractor receiving as inputs said left channel audio signal and right channel audio signal, and outputting a difference signal representing a difference between said left channel audio signal and said right channel audio signal;

a spectral weighting filter receiving said difference signal as an input and outputting a spectrally weighted signal; and

a cross-cancellation circuit for mixing said spectrally weighted signal with said left channel audio signal and said right channel audio signal, thereby generating a first speaker signal for said left speaker and a second speaker signal for said right speaker.

14. The system of claim 13, wherein said spectral weighting filter is characterized by a first filter region of relatively level gain, a second filter region having a generally decreasing gain with increasing frequency, and a third filter region of relatively level gain.

15. The system of claim 14, wherein said spectral weighting filter is further characterized by a roll-off from said first filter region to said second filter region at approximately 200 Hertz.

16. The system of claim 15, wherein said spectral weighting filter is further characterized by a boundary between said second filter region and said third filter region at approximately 2 KHz.

17. The system of claim 13, further comprising a phase equalizer interposed between said spectral weighting filter and said cross-cancellation circuit.

18. The system of claim 17, further comprising a first phase compensator interposed between said left channel audio signal and said cross-cancellation circuit, said first phase compensator having a phase characteristic complementary to a combined phase characteristic of said phase equalizer and said spectral weighting filter, and a second phase compensator interposed between said right channel audio signal and said cross-cancellation circuit, said second phase compensator having a phase characteristic complementary to said combined phase characteristic.

19. The system of claim 18, wherein said phase equalizer comprises a plurality of all pass filters, and wherein said first phase compensator and said second phase compensator each comprises a plurality of all pass filters having a substantially identical phase transfer function.

20. The system of claim 17, wherein said phase equalizer comprises a second order filter.

21. The system of claim 13, wherein said spectral weighting filter comprises a linear filter.

22. The system of claim 13, wherein said left channel audio signal comprises a surround left channel audio signal which is electrically connected to a surround left speaker, wherein said right channel audio signal comprises a surround right channel audio signal which is electrically connected to a surround right speaker, and wherein said first speaker and said second speaker comprise a surround back left speaker and a surround back right speaker, respectively, for utilization in a surround sound stereo system.

23. The system of claim 13, wherein one or more of said subtractor circuit, spectral weighting filter, and cross-cancellation circuit is implemented in whole or in part in the digital domain.

24. A method of sound reproduction, comprising the steps of:

placing a left speaker and a right speaker in close proximity;

receiving a left channel audio signal;

receiving a right channel audio signal;

generating a difference signal representing a difference between said left channel audio signal and said right channel audio signal;

applying a spectral weighting to said difference signal thereby generating a spectrally weighted signal; and

cross-canceling said spectrally weighted signal with said left channel audio signal and said right channel audio signal, thereby generating a first speaker signal for said left speaker and a second speaker signal for said right speaker.

25. The method of claim 24, wherein said step of generating said difference signal is carried out using a subtractor.

26. The method of claim 24, wherein said step of applying said spectral weighting to said difference signal is carried out using a spectral weighting filter, said spectral weighting filter being characterized by a first filter region of relatively level gain, a second filter region having a generally decreasing gain with increasing frequency, and a third filter region of relatively level gain.

27. The method of claim 26, wherein said spectral weighting filter is further characterized by a roll-off from said first filter region to said second filter region at approximately 200 Hertz.

28. The method of claim 27, wherein said spectral weighting filter is further characterized by a boundary between said second filter region and said third filter region at approximately 2 KHz.

29. The method of claim 24, further comprising the steps of:

performing phase equalization on said difference signal prior to said step of cross-canceling said spectrally weighted signal with said left channel audio signal and said right channel audio signal; and

performing phase compensation on each of said left channel audio signal and right channel audio signal to compensate for the spectral weighting and phase equalization performed on said difference signal.

30. The method of claim 29, wherein said step of performing phase equalization on said difference signal is carried out using a first plurality of all pass filters collectively having a first phase transfer function, and wherein said step of performing phase compensation on each of said left channel audio signal and right channel audio signal is carried out using a second and third plurality of all pass filters, said second plurality of all pass filters and said third plurality of all pass filters each having a collective phase transfer function complementary to a combined phase transfer function of said first phase

transfer function and a spectral weighting phase transfer function associated with the step of applying spectral weighting to said difference signal.

31. The method of claim 29, wherein said step of performing phase equalization is carried out using a second order filter.

32. The method of claim 24, wherein said step of applying said spectral weighting to said difference signal is carried out using a linear filter.

33. The method of claim 24, wherein said left channel audio signal comprises a surround left channel audio signal which is coupled to a surround left speaker, wherein said right channel audio signal comprises a surround right channel audio signal which is coupled to a surround right speaker, and wherein said left speaker and said right speaker comprise a surround back left speaker and a surround back right speaker, respectively, for utilization in a surround sound stereo system.

34. The method of claim 24, wherein one or more of said steps of generating said difference signal, applying a spectral weighting to said difference signal, and cross-canceling said spectrally weighted signal with said

left channel audio signal and said right channel audio signal is carried out in whole or in part in the digital domain.

35. A method for adaptively reproducing sound in a manner so as to enlarge the perceived area and stability of a stereo sound image, the method comprising the steps of:

placing a left speaker and a right speaker in close proximity;

receiving a left channel audio signal;

receiving a right channel audio signal; and

cross-canceling a spectrally weighted stereo difference signal with said left channel audio signal and said right channel audio signal prior to applying said left channel audio signal and said right channel audio signal to said left speaker and said right speaker, respectively, said spectrally weighted difference signal derived from said left channel audio signal and said right channel audio signal.

36. The method of claim 35, wherein said spectrally weighted difference signal is generated by obtaining a difference signal representing a difference between said left channel audio signal and said right channel audio signal, and applying said difference signal to a spectral weighting filter.

37. The method of claim 36, wherein said spectral weighting filter is characterized by a first filter region of relatively level gain, a second filter region having a generally decreasing gain with increasing frequency, and a third filter region of relatively level gain.

38. The method of claim 37, wherein said spectral weighting filter is further characterized by a roll-off from said first filter region to said second filter region at approximately 200 Hertz.

39. The method of claim 38, wherein said spectral weighting filter is further characterized by a boundary between said second filter region and said third filter region at approximately 2 KHz.

40. The method of claim 36, further comprising the step of performing phase equalization on an output of said spectral weighting filter prior to said step of cross-canceling said bass-enhanced stereo difference signal with said left channel audio signal and said right channel audio signal.

41. The method of claim 40, further comprising the step of performing phase compensation on each of said left channel audio signal and right

channel audio signal to compensate for said step of performing phase equalization on said output of said spectral weighting filter.

42. The method of claim 40, wherein said step of performing phase equalization on said output of said spectral weighting filter is carried out using a first plurality of all pass filters, and wherein said step of performing phase compensation on each of said left channel audio signal and right channel audio signal is carried out using a second and third plurality of all pass filters.

43. The method of claim 40, wherein said step of performing phase equalization is carried out using a second order filter.

44. The method of claim 36, wherein said spectral weighting filter comprises a linear filter.

45. The method of claim 35, wherein said left channel audio signal comprises a surround left channel audio signal which is coupled to a surround left speaker, wherein said right channel audio signal comprises a surround right channel audio signal which is also fed to a surround right speaker, and wherein said left speaker and said right speaker comprise a surround back left speaker

and a surround back right speaker, respectively, for utilization in a surround sound stereo system.

46. A sound reproduction system for a surround sound stereophonic system, comprising:

a surround left speaker;

a surround right speaker;

a pair of surround back speakers located in close proximity;

a surround left channel audio signal electrically connected to said surround left speaker;

a surround right channel audio signal electrically connected to said surround right speaker; and

a sound processor receiving as inputs said left channel audio signal and said right channel audio signal, said sound processor configured to generate a difference signal representing a difference between said surround left channel audio signal and said surround right channel audio signal, apply a spectral weighting to said difference signal thereby generating a spectrally weighted signal, and cross-cancel said spectrally weighted signal with said surround left channel audio signal and said surround right channel audio signal, thereby generating a first speaker signal and a second speaker signal for said pair of surround back speakers.

47. The sound reproduction system of claim 46, wherein said pair of surround back speakers comprises a surround left back speaker and a surround right back speaker.

48. The sound reproduction system of claim 46, wherein said pair of surround back speakers are located in a single speaker enclosure.

49. The sound reproduction system of claim 46, further comprising a left speaker, a right speaker, and a center speaker.

50. The sound reproduction system of claim 46, further comprising a first adaptive decorrelation circuit interposed between said surround left channel audio signal and said surround left speaker, and a second adaptive decorrelation circuit interposed between said surround right channel audio signal and said surround right speaker.

51. The sound reproduction system of claim 46, wherein said sound processor comprises a spectral weighting filter for applying said spectral weighting to said difference signal, said spectral weighting filter being characterized by a first filter region of relatively level gain, a second filter region

having a generally decreasing gain with increasing frequency, and a third filter region of relatively level gain.

52. The sound reproduction system of claim 51, wherein said spectral weighting filter is further characterized by a roll-off from said first filter region to said second filter region at approximately 200 Hertz.

53. The sound reproduction system of claim 52, wherein said spectral weighting filter is further characterized by a boundary between said second filter region and said third filter region at approximately 2 KHz.

54. The sound reproduction system of claim 46, wherein said sound processor further comprises a phase equalizer for equalizing the phase of said difference signal prior to cross-cancellation, and a plurality of phase compensators complementary in phase characteristics to a combined phase characteristic of said phase equalizer and said spectral weighting filter, said phase compensators placed in series along each of said surround left channel audio signal and surround right channel audio signal, respectively, prior to cross-cancellation.

55. The sound reproduction system of claim 54, wherein said phase equalizer comprises a plurality of all pass filters, and wherein each of said phase compensators comprises a plurality of all pass filters.

56. The sound reproduction system of claim 46, wherein said sound processor comprises a linear filter for applying the spectral weighting to said difference signal.

57. The sound reproduction system of claim 46, wherein said surround left speaker and said surround right speaker are each dipole speakers.

58. A sound reproduction system, comprising:

a left speaker and a right speaker positioned within a distance corresponding to a wavelength of a highest frequency intended to be radiated by the left and right speakers; and

a sound processor receiving a left channel audio signal and a right channel audio signal, said sound processor configured to mix opposite-polarity, spectrally-weighted cross-cancellation signals with the left channel audio signal and the right channel audio signal prior to applying the left channel audio signal and the right channel audio signal to the left speaker and the right speaker,

respectively, thereby enlarging an apparent sound image generated by the left and right speakers.